Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UPES

End Semester Examination, May 2023

Programme Name: B. Tech APE UP **Semester : VI**

Course Name : Well Testing and Well Stimulation **Time : 03 hrs**

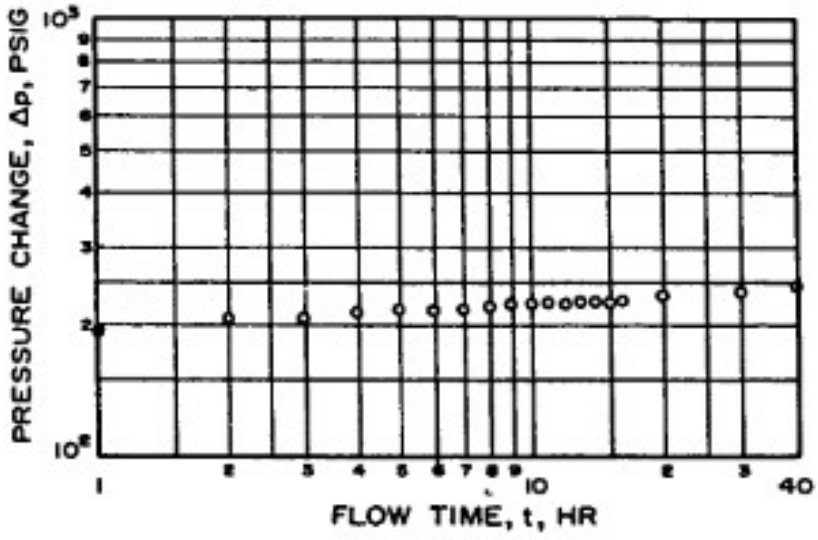
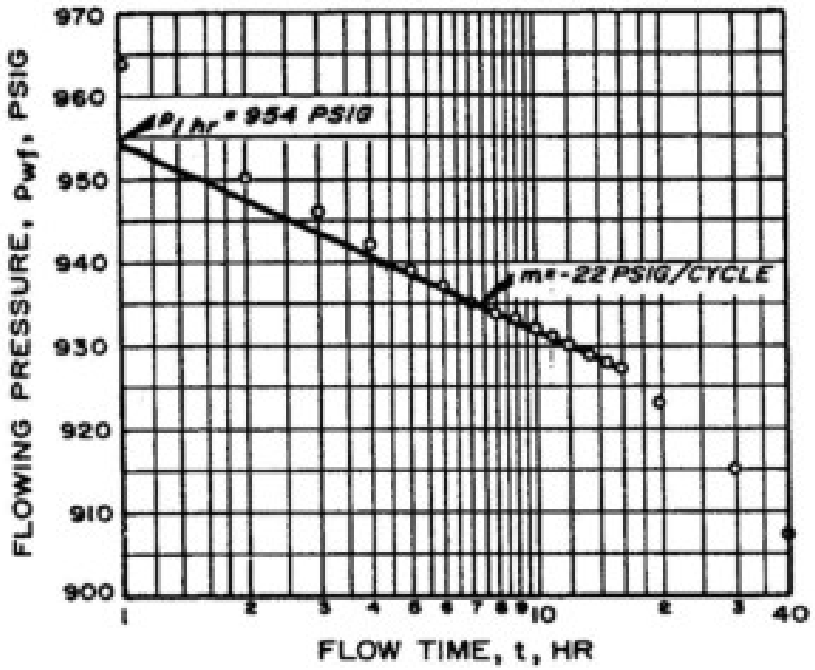
Course Code : PEAU 3032 **Max. Marks: 100**

Instructions :

- All questions are compulsory. However, internal choice has been provided. You have to attempt only one of the alternatives.
- Please use the graph papers.

SECTION A (20 marks)

S. No.		Marks	CO
1	Discuss the diffusivity equation.	4	CO1
2	Enumerate the different type curves used for well testing.	4	CO3
3	Diagrammatically explain the Horner's plot for following conditions: a) Hydraulically fractured well b) Well with major heterogeneities	4	CO2
4	Differentiate between matrix acidizing and hydraulic fracturing.	4	CO4
5	Calculate the pore volume of the reservoir when the centered well is flowing at 1000 STB/D for 10 days. The OFVF is 1 RB/STB and the C_t is 2x 10^{-6} psi^{-1}. The pressure differential recorded by the pressure gauge is 500 psi.	4	CO1
SECTION B (40 marks)			
6	A pressure build-up test analysis for a well with q = 83 STB/D, B = 1.12 RB/STB, μ= 3.15 cp, h =12 ft, rw = 0.265 ft, and pavg - pwf = 265 psia k = 155 mD s = 2.2. Find the pressure drop across the skin, the flow efficiency, the damage ratio, the damage factor, and the apparent wellbore radius.	10	CO1
7	Discuss the steps of performing Drill stem test in a newly drilled well.	10	CO3

8	Estimate oil permeability and skin factor from the draw down data of given figures: log-log and semi-log plots. Know reservoir data are:- h = 130 ft $\phi = 0.20$ $r_w = 0.25$ ft, $q_o = 348$ STB/D B = 1.14 RB/STB $\mu = 3.93$ cp $C_t = 8.74 \times 10^{-6}$ psi^{-1}   	**10**	**C02**

<table>
<tr><td>9</td><td>Discuss the Horner's plot. Also describe the various parameters determined from ETR, MTR and LTR.</td><td>10</td><td>CO3</td></tr>
<tr><td colspan="4">SECTION-C (40 marks)</td></tr>
<tr><td>10</td><td>A 60-ft thick, 50-md sandstone pay zone at a depth of 9,500 ft is to be acidized with an acid solution having a specific gravity of 1.07 and a viscosity of 1.5 cp down a 2-in. inside diameter (ID) coil tubing. The formation fracture gradient is 0.7 psi/ft. The wellbore radius is 0.328 ft. Assuming a reservoir pressure of 4,000 psia, drainage area radius of 1,000 ft, and a skin factor of 15.
Calculate :
(a) The maximum acid injection rate using safety margin 300 psi.
(b) The maximum expected surface injection pressure at the maximum injection rate.</td><td>20</td><td>CO4</td></tr>
<tr><td>11</td><td>Estimate the AOF of the tested well using
a)empirical method b)theoretical method

<table><tr><th>Test</th><th>Duration (Hours)</th><th>Pressure (Psi)</th><th>Gas flow rate (MMSCF/D)</th></tr><tr><td>Initial shut-In</td><td>48</td><td>1952</td><td>0</td></tr><tr><td>First flow</td><td>12</td><td>1761</td><td>2.6</td></tr><tr><td>First Shut in</td><td>15</td><td>1952</td><td>0</td></tr><tr><td>Second flow</td><td>12</td><td>1694</td><td>3.3</td></tr><tr><td>Second Shut in</td><td>17</td><td>1952</td><td>0</td></tr><tr><td>Third flow</td><td>12</td><td>1510</td><td>5</td></tr><tr><td>Third shut in</td><td>18</td><td>1952</td><td>0</td></tr><tr><td>Fourth Flow</td><td>12</td><td>1320</td><td>6.3</td></tr><tr><td>Extended flow</td><td>72</td><td>1151</td><td>6</td></tr><tr><td>Final Shut in</td><td>100</td><td>1952</td><td>0</td></tr></table>
OR

Describe with the help of graphs the different types of gas well testing. Discuss the empirical and theoretical method of determining AOF in as wells.</td><td>20</td><td>CO3</td></tr>
</table>

Formula Sheet

Slope of semi-log straight line, psi/cycle: $m = \dfrac{162.6q\mu B_o}{kh}$

Radius of investigation. ft: $r \approx \sqrt{\dfrac{kt}{948\phi\mu c_t}}$

Permeability-thickness product for double porosity reservoirs, mD-ft $(kh)_f = \hat{k}_f h = \dfrac{162.6q\mu B}{m}$

Average fracture permeability, mD $\hat{k}_f = \hat{k}_f h / h$

Skin factor for buildup test: $S = 1.151\left(\dfrac{p(1hr) - p_{wf}(\Delta t = 0)}{|m|} - \log\left(\dfrac{k}{\phi\mu c_t r_w^2}\right) + 3.23\right)$

Skin factor for drawdown test: $S = 1.151\left(\dfrac{p_i - p(1hr)}{|m|} - \log\left(\dfrac{k}{\phi\mu c r_w^2}\right) + 3.23\right)$

Pseudo steady state equations: $\dfrac{dp_w}{dt} = -\dfrac{0.234qB_o}{c_t V_P}$, (psi/hr)

$$p(r_w, t) = p_i - \frac{0.0744qB_o t}{\phi c_t h r_e^2} + \frac{q\mu B_o}{0.00708kh}\left[\ln\left(\frac{r_e}{r_w}\right) - \frac{3}{4} + S\right]$$

Horner time ratio: $\dfrac{t_p + \Delta t}{\Delta t}$

Distance to fault, ft: $L = \sqrt{\dfrac{0.000148k\Delta t}{\phi\mu c_t}}$

The approximate time required for the slope to double, hr $\Delta t = \dfrac{3.8\times10^5 \phi\mu c_t L^2}{k}$

$$p(r,t) = p_i - \frac{q\mu B_o}{0.00708kh} p_D, \qquad \eta = \frac{0.0002637k}{\phi\mu c_t}, \qquad t_D = \frac{\eta t}{r^2}$$

$p_D = \dfrac{1}{2}(\ln t_D + 0.809)$ only if $t_D > 100$, for $t_D < 100$ use the provide p_D graph.

$$p(r,t) = p_i - \frac{0.141q\mu B_o}{kh}(p_D + S)$$

Gas wells build up

$$m = \frac{1637q_g T}{kh}$$

$$S' = 1.151\left(\left(\frac{p_{1hr} - p_{pwf}(@\Delta t = 0)}{m}\right) - \log\left(\frac{k}{\phi\mu c_t r_w^2}\right) + 3.23\right)$$